# Jason-1 Sea Surface Height Anomaly (Product 132)
# User's Handbook

## DATA PRODUCT ABSTRACT

This document describes Version 3 of the JASON-1 Sea Surface Height Anomaly (J1SSHA) Product dataset which is produced by the Jet Propulsion Laboratory, Physical Oceanography Distributed Active Archive Center (JPL PO.DAAC). This dataset is derived from the JASON-1 Interim Geophysical Data Record (IGDR) for near realtime applications or from the Geophysical Data Record (GDR). The J1SSHA is organized as 10-day cycles and pass files, the same as the (I)GDR. Each pass file of the SSHA consists of header records followed by data records containing 11 parameters: time of record in days and milliseconds, latitude, longitude, sea surface height anomaly, significant wave height, inverse barometer, sigma0, total electron content of the atmosphere, ocean depth, and mean sea surface. It is swath data and no images are provided with this product.

The Sea Surface Height Anomaly, the objective parameter in this product, represents the difference between the best estimate of the sea surface height and a mean sea surface. The sea surface height used was corrected for atmospheric effects (ionosphere, wet and dry troposphere), effects due to surface conditions (electromagnetic bias), and other contributions (ocean tides, pole tide, and inverse barometer). Because some users may want to provide their own values for the mean sea surface and inverse barometer effect, the values used in calculating the sea surface height anomaly are included in the data product.

Read software is provided to display the header records and the parameters of each data record. Analysis of the data is the responsibility of the user, although Edit Criteria are provided in this document, which describes the method for calculating the sea surface height anomaly. The Jason-1 SSHA product and read software can be downloaded from anonymous FTP site podaac.jpl.nasa.gov in directory pub/sea_surface_height/jason/j1_ssha

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# 1. INVESTIGATOR'S NAME AND CREDIT

Robert Berwin created this product and documentation.

If this data product is used for publication, please include the following acknowledgement:
The Jason-1 SSHA data were created by Robert Berwin and obtained from JPL Physical Oceanography DAAC.

# 2. DATA DESCRIPTION

## 2.1. FILENAMING CONVENTION

### 2.1.1. Cycle Header File

The cycle header file has the following label: j1sshatvgccc.hdr

j1 = Jason-1

ssha = Sea Surface Height Anomaly

t = "g" or "i" specifying the type of Jason-1 pass file used for input data:
g = GDR, i = IGDR

v = J1SSHA product version (1,2,...)

g = Jason-1 pass file product generation (a,...) taken from name of the pass file. For example, if the Jason-1 pass file is: JA1_IGD_2PaP010_112.CNES, then the product generation letter is a (the letter between PaP in the filename.

ccc = cycle number

### 2.1.2. Pass File

The pass file has the following label: j1sshatvgccc.ppp

This file name has the same labeling as the cycle header file except hdr is replaced by the pass number, ppp.

## 2.2. FILE FORMAT

For each cycle, there is a cycle header file consisting of ASCII records each with a fixed-length record of 80 bytes.

The pass files consist of 15 ASCII header records followed by N <= 3360 binary data records. Both the header and data records of the pass file have the same record length of 32 bytes. The data records are stored as big-endian binary.

Average data volumes are approximately 16 Mbytes per cycle and 62 KB per passfile. The ftp product on the PO.DAAC public ftp site is gzipped, giving approximately 12 MB per cycle and 46 KB per passfile.

## 2.3. TEMPORAL COVERAGE AND RESOLUTION

This data set starts January 15, 2002 with cycle 1, pass 2. Each cycle is approximately ten days long (9 days, 21 hours, 58 minutes, 31.3 seconds) and contains 127 orbits or 254 passes. A pass is approximately 56 minutes. The time difference between along track measurements is approximately 1 second. However, due to editing, where the data records from the (I)GDR do not meet certain parameter criteria, some of these records are not placed on the J1SSHA product. This editing may result in variable time intervals of data gaps. Refer to the Processing Methods section for me details.

## 2.4. SPATIAL COVERAGE AND RESOLUTION

One cycle surveys the entire Earth from 66.03° to -66.03° latitude. Each pass or swath is half a revolution between these two latitudes. Even numbered passes are descending (66.03° to -66.03°) and odd numbered passes are ascending (-66.03° to 66.03°). Along track measurements are approximately 6 km apart and the ground tracks are 315 km apart at the equator.

The reference ellipsoid is a smooth ellipsoidal approximation of the shape of the Earth with an equatorial radius of 6378.1363 km and a flattening coefficient of 1/298.257.

## 2.5. DATA PARAMETERS AND FORMAT

### 2.5.1. Pass Header Record

All records, header and data, in the pass file are 32 bytes. Each ASCII header record has a keyword and a value.

PASS HEADER RECORDS

| Record# | Name | Description |
|---|---|---|
| 1 | Producer=NASA/JPL/PODAAC ; | Name of government agency that produced this passfile. |
| 2 | Source/Sensor=Jason-1/POSDN-2; | Source refers to the spacecraft which contains the sensors, the Jason-1 spacecraft, and Sensor refers to the instrument which acquired the data. |
| 3 | Create_Time=YYYY-MM-DDTHH:MM:SS; | UTC date when this passfile was generated. |
| 4 | S/W_Name=Jason-1 SSHA; | Software name that generated this passfile. |

| | | |
|---|---|---|
| 5 | Build_Version=J1SSHA Vn; | Build version of this product. n = build version number |
| 6 | Product_Version=Vn; | Product version of this product. n = product version number |
| 7 | Pass=JA1_GDR_2PxPccc_ppp.NASA;<br>--- or ---<br>Pass=JA1_IGD_2PxPccc_ppp.NASA; | The GDR or IGDR pass file name used to generate the Sea Surface Height Anomaly. 'x' in the filename indicates production version by CNES and NASA. |
| 8 | Cycle_Number=nnn; | Cycle number corresponding to this passfile. |
| 9 | Pass_Number=nnn; | Pass number of this passfile. |
| 10 | Data_Count=nnnn; | Number of data records in this passfile. |
| 11 | J1_SSH_Bias = nnn mm; | Contains the Jason1 sea surface height (absolute) bias in millimeters. This bias is subtracted from the j1ssha parameter in the Pass Data Record.<br><br>Refer to the Editing and J1SSHA Calculation Section |
| 12 | Rev_Number=nnnnn; | Revolution number counted from launch. |
| 13 | Equ_Longitude=+/-xxx.xx; | East longitude where this pass crosses the Equator. |
| 14 | Equt=YYYY-MM-DDTHH:MM:SSSSSS; | UTC date and time where this pass crosses the Equator. |
| 15 | Frst=YYYY-MM-DDTHH:MM:SSSSSS; | UTC date and time of the first data record in the pass. |
| 16 | Last=YYYY-MM-DDTHH:MM:SSSSSS; | UTC date and time of the last data record in the pass. |
| 17 | Epch=YYYY-MM-DDTHH:MM:SSSSSS; | UTC reference date and time. |
| 18 | Global_Avg_Press=xxxx.xx mbar; | The atmospheric global average pressure from meteo fields. This pressure, in units of millibars, corresponds to the first record of the pass and is used for the entire pass file. The value is taken from Jason-1 (I)GDR pass header. |

As the (I)GDR passfile is read to generate the J1SSHA passfile, each data record is edited for "good" records (Refer to the Section: Processing Methods). If the record passes the edit criteria, then the sea surface height anomaly is calculated using parameters from that record. Therefore, the J1SSHA passfile contains only those records from the (I)GDR passfile which passed the edit criteria. The pass header parameter, Data_Count, gives the total number of these "good" data records.

### 2.5.2. Sample Pass Header

Producer=NASA/JPL/PODAAC;
Source/Sensor=Jason-1/POSDN-2;
Create_Time=2007-01-04T21:14:39;
S/W_Name=Jason-1 SSHA;
Build_Version=J1SSHA V2;
Product_Version=V2;
Pass=JA1_GDR_2PbP180_254.CNES;
Cycle_Number=180;
Pass_Number=254;
Data_Count= 813;
J1_SSH_Bias=131 mm;
Rev_Number=22861;
Equ_Longitude=+294.10<deg>;
Equt=2006-12-05T00:17:51.772000;
Frst=2006-12-05T00:06:42.219238;
Last=2006-12-05T00:42:13.439142;
Epch=1958-01-01T00:00:00.000000;
Global_Avg_Press= 1010.3 mbar

### 2.5.3. Pass File

All records, header and data, in the pass file are 32 bytes. Each ASCII header record has a keyword and a value.

For example, the first header record is

Producer=NASA/JPL/PODAAC;cbbbbbb

where b=symbol for an ASCII blank character and c = null character. The null character signals the end of the string and is not displayable.

### 2.5.4. Pass Data Record

The record size is 32 bytes, which is a multiple of 4, making it convenient for software read programs.

All parameters are stored in binary format and the data types are defined as follows:
signed long/unsigned long: 4 byte signed/unsigned integer

signed short/unsigned short: 2 byte signed/unsigned integer
signed char/unsigned char: 1 byte signed/unsigned integer
In cases where the parameter is invalid or missing, default values are assigned the maximum possible value for the size and type of the parameter:

DEFAULT VALUES

| Type | Bytes | Default Value |
|---|---|---|
| signed char | 1 byte | 127 |
| unsigned char | 1 byte | 255 |
| signed short | 2 bytes | 32767 |
| unsigned short | 2 bytes | 65535 |
| signed long | 4 bytes | 2147483647 |
| unsigned long | 4 bytes | 4294967295 |

PASS DATA RECORD

| Field# | Name | Size | Type | Description | Units |
|---|---|---|---|---|---|
| 1 | days | 2 | unsigned short | Days from reference date(1) | days |
| 2 | millisecs | 4 | unsigned long | Milliseconds within the day | milliseconds |
| 3 | latitude | 4 | signed long | Geodetic Latitude | microdeg |
| 4 | longitude | 4 | unsigned long | Geodetic Longitude | microdeg |
| 5 | j1ssha | 2 | signed short | Sea Surface Height Anomaly | $10^{-4}$ meter |
| 6 | swh_ku | 2 | unsigned short | Ku Significant Wave Height | mm |
| 7 | inv_bar_corr | 2 | signed short | Inverse Barometer | $10^{-4}$ meter |
| 8 | sigma0_ku | 2 | unsigned short | Ku Backscatter Coefficient | $10^{-2}$ dB |
| 9 | tec | 2 | signed short | Total Electron Content | tecu(2) |
| 10 | bathymetry | 2 | signed short | Ocean Depth | meter |
| 11 | mss | 4 | signed long | Mean Sea Surface | 10-4 meter |
| 12 | hf_fluctuations_corr | 2 | unsigned short | High Frequency Fluctuations of the sea surface topography | $10^{-4}$ meter |

(1) Reference date = January 1, 1958 00:00:00.00, referred to as UTC58.
(2) 1 TECU = 1016 electrons/square meter

### 2.5.5. Sample Pass Data Record

```
days        = [     17870] 000045ce
millisecs   = [    402219] 0006232b
latitude    = [  32402771] 01EE6D53 (microdeg)
longitude   = [ 280613898] 10B9D40A (microdeg)
ssha        = [        60] 0000003C (10-4 m)
swh_ku      = [      1374] 0000055e (mm)
inv_bar_corr = [     -1597] fffff9c3 (10-4 m)
sigma0_ku   = [      1206] 000004B6 (0.01 dB)
tec         = [         6] 00000006 (tecu:10**16 e/m2)
bathymetry  = [       -67] FFFFFFBD (m)
mss         = [   -353061] FFFA9CDB (10-4 m)
spare       = [         0] 00000000 (n/a)
```

### 2.5.6. Pass File Parameters

Parameters appear in the order in which they occur in the Pass Data Record.

days

Definition

UTC time measured from the Reference Epoch start date, Jan 1, 1958, 0 hrs, 0 min, 0 sec.

millisecs

Definition

Number of milliseconds within the current day.

latitude

Definition

Geodetic latitude in microdegrees.

Discussion

Typical latitude range is limited to -66 to +66 degrees by the inclination of the satellite orbit.

longitude

Definition

Geodetic longitude in microdegrees.

j1ssha

Definition

Sea Surface Height Anomaly in $10^{-4}$ m.

Discussion

The Sea Surface Height Anomaly is the height of the sea surface with respect to the mean sea surface. Refer to the Processing Methods section for a discussion of how this parameter is derived.

swh_ku

Definition

Ku band one per frame significant wave height in millimeters.

Discussion

This parameter is included in this product for those interested in SWH measurements and is not used directly in calculating the J1SSHA. It also can be used along with sigma0_ku to calculate a wind speed estimate.

inv_bar_corr

Definition

Inverse Barometer correction in $10^{-4}$ m.

Discussion

The inverse barometer correction removes the effect that higher or lower than normal atmospheric pressure has on the sea surface. The value given HAS ALREADY BEEN APPLIED to get the J1SSHA. If you are satisfied with it, then there is nothing you need to do. What follows describes how it was obtained.

INV_BAR is calculated as the difference between the pressure at that latitude-longitude-time (from the dry tropo correction) and a constant value. In the MGDR the constant is 1013.3, but in this dataset it is the average over the global oceans and 1 day of NCEP pressure at sea level. This daily-average atmospheric pressure is written into the pass file header.

The daily-average atmospheric pressure is calculated by NOAA (ftp.ncep.noaa.gov) consisting of a 1x1 degree global data set where the pressures are reduced to mean sea level. From this the two daily values, 0th and 12th hours, are averaged by applying a land mask (to provide ocean only values) and a cosine latitude weighting.

The inverse barometer correction (in millimeters) is calculated by the following formula:

INV_BAR = -9.948*(P_atm - Average_Atm_Pressure)

In this data product, the Average_Atm_Pressure is the daily average pressure described above and placed in the data header. In the MGDR product, a constant value of 1013.3 millibar was used.

P_atm is the sea level atmospheric pressure in millibars obtained indirectly from the dry tropospheric correction (refer to Reference 1).

If you wish to use other values of Mean_Atm_Pressure, solve the above equation for P_atm, then recalculate INV_BAR.

sigma0_ku

Definition

Ku band backscatter coefficient on 0.01 dB.

Discussion

This parameter, along with swh_ku, is copied from the Jason-1 (I)GDR and a bias[1] applied. It is included in this product for those who wish to calculate a wind speed estimate and is not used directly in calculating the J1SSHA.

(1) A bias of 2.26 dB has been subtracted from the sigma0_ku value obtained from the Jason-1 (I)GDR to be consistent with the TOPEX/POSEIDON SSHA sigma0 values.

tec

Definition

Total Electron Content in 1016 electrons/$m^2$

Discussion

This parameter is included in this product for those interested in ionospheric total electron content and is not used directly in calculating the J1SSHA.

$TEC = (dR * f^2) / -403.0$

where

TEC = total electron content in TECU (1016 electrons/$m^2$)
dR = ionosphere range correction in Ku band (mm), obtained from the Jason-1 (I)GDR.
f = frequency of the Ku beam (13.6 GHz)

bathymetry

Definition

Ocean depth in meters.

Discussion

Ocean depth is computed from the ocean depth DTM2000.1 model. See Ref. 3 for further discussion. While all good ocean data are included in this product, users usually want to use only data from deep water where tide models are more accurate and to get away from shelf effects. Typically, deep water is considered to be 1000 meters or greater.

mss

Definition

Mean Sea Surface Height above the reference ellipsoid in $10^{-4}$ m

Discussion

The value of the mean sea surface used in this product to calculate J1SSHA is from the CLS01 model and data. The mean sea surface is included in the data record so users can use their own mean sea surface, if they so choose.

## 2.6. Cycle Header Description

A cycle header consists of 15 ASCII records followed by 1-254 ASCII Reference records. The Reference records list all the pass files in the cycle. The format of a Reference records is: Reference = <passfile label>; (see Labeling). The record length of the header records is 80 bytes. Each record consists of a keyword and a value.

CYCLE HEADER RECORDS

| Record# | Name | Description |
|---|---|---|
| 1 | Producer_Agency_Name=NASA; | Name of government agency that produced this file |
| 2 | Producer_Institution_Name=JPL; | Producer Institution |
| 3 | Source_Name=Jason-1; | Name of Project |
| 4 | Sensor_Name=Poseidon-2(CNES); | Name of Spacecraft Sensor |
| 5 | Data_Handbook_Reference=Jason-1 SSHA URM, V1.0; | Name, Version of User Reference Handbook |
| 6 | Product_Create_Time=YYYY-MM-DDTHH:MM:SS; | UTC date when this product file was generated |
| 7 | Generating_Software_Name=Sea_Surface_Height_Anomaly; | Name of software that generated this file |
| 8 | Build_Version=J1 SSHA Vn; | Build version of this product. n = build version number |
| 9 | Product_Version=Vn; | Product version of this product. n = product version number |
| 10 | Pass_File_Data_Type=J1SSHA; | Product type |
| 11 | Cycle_Number=nnn; | Cycle number of (I)GDR file used for this file |
| 12 | Package_Data_Start_Time=YYYY-MM-DDTHH:MM:SS.SSSSSS; | UTC date of the first record of this file |
| 13 | Package_Data_End_Time=YYYY-MM-DDTHH:MM:SS.SSSSSS; | UTC date of the last record of this file |
| 14 | Start_Pass_Number=nnn; | Pass number of the first non-empty pass file within the current cycle. The range of values is 1-254. |
| 15 | End_Pass_Number=nnn; | Pass number of the last non-empty pass file within the current cycle. The range of values is 1-254. |
| 16 | Pass_Count=nnn; | Total number of non-empty pass files within the current cycle. The range of values is 1-254. |
| 17-nnn | Reference=j1sshatvgccc.ppp; | Name of the pass files within the current cycle. There is one of these records for every pass file. |

### 2.6.1. Cycle sample header

Producer_Agency_Name = NASA/JPL/PODAAC;
Producer_Institution_Name = JPL;
Source_Name = JASON-1;
Sensor_Name = Poseidon-2(CNES);
Data_Handbook_Reference = Jason-1 SSHA URM, V1.0;
Product_Create_Time = 2007-01-04T15:39:23;
Generating_Software_Name = Sea Surface_Height Anomaly;
Build_Version = J1SSHA V2;
Product_Version = V2;
Pass_File_Data_Type = J1SSHA;
Cycle_Number = 180;
Package_Data_Start_Time = 2006-11-25T02:53:44.840443;
Package_Data_End_Time = 2006-12-05T00:42:13.439142;
Start_Pass_Number = 001;
End_Pass_Number = 254;
Pass_Count = 254;
Reference = j1sshag2b180.001;
Reference = j1sshag2b180.002;
Reference = j1sshag2b180.003;
Reference = j1sshag2b180.004;
Reference = j1sshag2b180.005;

## 3. AVAILABLE READ SOFTWARE

Read software is available for C and IDL at PO.DAAC's anonymous ftp site in directory pub/sea_surface_height/jason/j1_ssha/software.

## 4. PROCESSING METHODS

### 4.1. Editing and J1SSHA Calculation

Presented here are the formulas for calculating the Sea Surface Anomaly parameter, J1SSHA, from the 1/second JASON-1 Geophysical Data Record, (I)GDR pass file data. The formulas for the Sea Surface Height Anomaly were taken from Ref. 1.

Default values are assigned to (I)GDR parameters when the value is missing, flagged, or invalid.

Editing
The following editing criteria are for finding good records from the (I)GDR, that is, those which are used to calculate the sea level anomaly. These criteria were taken from Reference 1.

The JASON-1 record is good if

PRIMARY EDITING

| | |
|---|---|
| surface_type = 0 | open oceans or semi-enclosed seas |
| alt_echo_type = 0 | ocean-like |
| rad_surface_type = 0 | ocean |
| qual_1hz_alt_data = 0 (all bits) | Ku band range is good |
| qual_1hz_alt_instr_corr = 0 (all bits) | Ku band range instrument correction is good |
| qual_1hz_rad_data = 0 (all bits) | bright temperature (all channels) are good |
| orb_state_flag = 3 | adjusted (preliminary/precise) orbit |
| altitude | not default value |
| range_ku | not default value |
| model_dry_tropo_corr | not default value |
| rad_wet_tropo_corr | not default value |
| iono_corr_alt_ku | not default value |
| sea_state_bias_ku | not default value |
| mss | not default value |
| inv_bar_corr | not default value |
| ocean_tide_sol1 | not default value |
| solid_earth_tide | not default value |
| pole_tide | not default value |
| ecmwf_meteo_map_avail = 0 | ECMWF meteorological map is available |
| tp_interp_flag = 0 or 1 | radiometer interpolation flag is good |
| rain_flag = 0 | no rain |
| ice_flag = 0 | no ice |
| interp_flag bit 0 = 0 | mss interpolation flag good |
| interp_flag bit 1 = 0 | ocean_tide_sol1 interpolation flag is good |
| interp_flag bit 3 = 0 | meteorological data interpolation flag is good |

ADDITIONAL EDITING

| |
|---|
| Number of valid points (range_numval_ku) >= 10 |
| 0 mm <= RMS of 1/sec range (range_rms_ku) <= 200 mm |
| -130,000 mm <= (altitude - range_ku) <= 100,000 mm |
| -2500 mm < dry tropospheric correction (model_dry_tropo_corr) < -1900 mm |
| -500 mm <= wet_tropospheric correction (rad_wet_tropo_corr) <= -1 mm |
| -400 mm <= ionospheric correction (iono_corr_alt_k) <= 40 mm |
| -500 mm <= sea state bias correction (sea_state_bias_ku) <= 0 mm |
| -5000 mm <= ocean tide correction (ocean_tide_sol1) <= 5000 mm |
| -1000 mm <= solid earth tide correction (solid_earth_tide) <= 1000 mm |
| -150 mm <= pole tide correction (pole_tide) <= 150 mm |
| 0 mm <= significant waveheight (swh_ku) <= 11000 mm |
| 7 dB <= sigma naught (sig0_ku) <= 30 dB |
| 0 m/s <= altimeter wind speed (wind_speed_alt) <= 30 m/s |
| -0.2 $deg^2$ <= square of off nadir angle from waveforms (off_nadir_angle_ku_wvf) <= 0.64 $deg^2$ |

### 4.2. J1SSHA Calculation: Derivation from the GDR

The sea surface height anomaly is derived by the following formula. The parameters in bold are the names of the Jason-1 parameters in the GDR.

j1ssha = Sea Surface Height - Tide Effects - Inverse Barometer
- Mean Sea Surface - High Frequency Wind Response

where Sea Surface Height = Altitude - Corrected Range

Corrected Range = Range + Wet Troposphere Correction
+ Dry Troposphere Correction
+ Ionosphere Correction
+ Sea State Bias
+ Datation Bias Correction

Tide Effects = Geocentric Ocean Tide
+ Solid Earth Tide
+ Pole Tide

| Other Definitions | (I)GDR Parameter |
|---|---|
| Altitude | = **altitude** |
| Range | = **range_ku** |
| Wet Troposphere Correction | = **rad_wet_tropo_corr** |
| Dry Troposphere Correction | = **model_dry_tropo_corr** |
| Ionosphere Correction | = **iono_corr_alt_ku** |
| Sea State Bias | = **sea_state_bias_ku** |
| Datation Bias Correction | = **pseudo_datation_bias_corr_ku** |
| Geocentric Ocean Tide | = **ocean_tide_sol1** |
| Solid Earth Tide | = **solid_earth_tide** |
| Pole Tide | = **pole_tide** |
| Inverse Barometer | = **inv_bar_corr** |
| High Frequency Wind Response | = **hf_fluctuations_corr** |
| Mean Sea Surface | = **mss** |

The **ocean_tide_sol1** parameter is the sum of:

Diurnal + Semidiurnal ocean tide from the GOT00.2 and FES2004 tide models,
Diurnal + Semidiurnal load tide (load_tide_sol1), and
Equilibrium long-period ocean tide height (ocean_tide_eq_lp)

The resultant formula for the sea surface height anomaly is:

j1ssha **= altitude - range_ku**
**- rad_wet_tropo_corr**
**- model_dry_tropo_corr**
**- iono_corr_alt_ku**
**- sea_state_bias_ku**
**- pseudo_datation_bias_corr_ku**
**- ocean_tide_sol1**
**- solid_earth_tide**
**- pole_tide**
**- inv_bar_corr**
**- hf_fluctuations_corr**
**- mss**
- 96.4 mm[(a)]

(a): Based on recommendations from Eric Leuliete at NOAA, a TOPEX/POSEIDON/Jason-1 absolute bias of 96.4 mm is applied to the j1ssha value to align TOPEX/POSEIDON and Jason-1 data.

**altitude - range_ku** is the height of the actual sea surface above the reference ellipsoid. The terms **rad_wet_tropo_corr** and **model_dry_tropo_corr** represent the wet and dry atmospheric corrections, respectively. **iono_corr_alt_ku** is the ionosphere correction. **sea_state_bias_ku** is the air-sea interface correction. **pseudo_datation_bias_corr_ku** corrects for the bias due to Doppler velocity. Thus, **range_ku** - **model_dry_tropo_corr** - **iono_corr_alt_ku** - **rad_wet_tropo_corr** - **sea_state_bias_ku** - **pseudo_datation_bias_corr_ku** is the so-called "corrected range", where range_ku is the raw range corrected for instrumental effects only.

Next, the contributions of the inverse barometer, **inv_bar_corr**, and tide effects, **ocean_tide_sol1** (which includes the Diurnal + Semidiurnal ocean tide, Diurnal + Semidiurnal load tide, and equilibrium long-period ocean tide), **solid_earth_tide**, and **pole_tide**, and the high frequency wind response, **hf_fluctuations_corr**, are subtracted, leaving only the "calm" sea surface height above the reference ellipsoid as if there were ideally no tides, no atmosphere, and no air-sea interactions.

Finally, the mean sea surface, mss, is subtracted, leaving only the relatively small distance between this "calm" sea surface and the Mean Sea Surface.

## 5. CALIBRATION INFORMATION

The calibration/validation document can be found at
http://podaac.jpl.nasa.gov/jason/documents/calval4.0.pdf

Additional documents are located at

http://www.aviso.oceanobs.com/en/newsstand/newsletter/newsletter10/index.html

Chambers, D.P., J. C. Roes, T.j. Urban. 2003. Calibration and verification of Jason-1 using along-track residual with TOPEX. *Marine Geodesy*. Vol. 26, no. 3-4, pg. 305-317.

MacMillan, D., Y. Bock, P. Fang, B. Beckely, C. Ma. Calibartion of the TOPEX and Jason-1 altimeter microwave radiometers using VLBI and GPS derived tropospheric delays. http://sealevel.jpl.nasa.gov/science/invest-macmillan.html

## 6. SOURCES OF ERROR

This product has been edited so only valid data are used, i.e. no effects from high winds, ice, rain, etc. For more information on the flags used refer to the Processing Method section and reference 1.

## 7. REFERENCES

1. AVISO and PO.DAAC User Handbook, IGDR and GDR Jason Products, CNES/NASA, JPL D21352(PODAAC), Edition 4.1, November, 2008, ftp://podaac.jpl.nasa.gov/pub/sea_surface_height/jason/gdr/doc/Handbook_Jason_v4-1.pdf

2. Benada, J.R., "PO.DAAC Merged GDR (TOPEX/POSEIDON) Generation B User's Handbook", Version 2.0, July 30, 1997.
See the JPL PO.DAAC Web page: http://podaac.jpl.nasa.gov, where this User's Handbook can be viewed on-line.

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This document is an excellent primer to satellite altimetry. For a PDF version: http://oceanesip.jpl.nasa.gov/sealevel/wocealt87.pdf

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## 8. ACRONYMS

| | |
|---|---|
| AVISO | Archivage, Validation et Interprtation des donnes des Satellites |
| CCSDS | Consultative Committee on Space Data System |
| CDS | CCSDS Day Segmented Time Code |

| | |
|---|---|
| CNES | Centre National d'Etudes Spatiales (French Space Agency) |
| GDR | Geophysical Data Record |
| JPL | Jet Propulsion Laboratory |
| MGDR | Merged Geophysical Data Record |
| MSS | Mean Sea Surface |
| PO.DAAC | Physical Oceanography Distributed Active Archive Center |
| J1SSHA | Jason-1 Sea Surface Height Anomaly |
| SWH | Significant Wave Height |
| TEC | Total Electron Content |
| TECU | Total Electron Content Units (10**16 electrons/m^2) |
| TOPEX | ocean TOPography EXperiment |
| TPSSHA | TOPEX/POSEIDON Sea Surface Height Anomaly |
| J1 | JASON-1 |
| UTC | Universal Time Coordinated |

## 9. CONTACT INFORMATION

Questions or comments about this data product should be directed via email to the Physical Oceanography DAAC: podaac@podaac.jpl.nasa.gov.

## 10. DOCUMENT INFORMATION

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